Rockwell-Downey Mission Support Room (MSR) and Data Display & Review (DDR) Room Upgrade

Ground Support System Methodology and Architecture

for Control Center Conference
University of Houston, Clear Lake
June 18, 1991

P. D. Schoen
Rockwell International SSD Downey
Aerospace Simulation and Systems Test Center
(213) 922-2534

P. D. Schoen
Synergistic Approach to Systems Test and Support
Building Block Architecture Provides Transportability of Data, Procedures and Knowledge

- Operational Support System
- Test Data
- Test Procedures
- Test Repeatability
- Failure Replication

- Production Test System
- LRU/SRU Depot

- Data

- Operational Environment
- Development Environment

- Integration Laboratory
- Manufacturer's Support Equipment
- System Level Tester

- Requirements
- Logistics & Engineering
Synergistic Approach lowers cost and risk for life cycle of a program

Life Cycle Elements

Operations
- Ground
- In-Flight
- Post Flight

Manufacturing & Systems Integration

Breadboard Brassboard

Design

Requirements Definition

Determination of Design Errors at the Earliest Phase Reduces Cost of Vehicle Ownership

RI-SSD

6/15/91

P. D. Schoen

Rockwell International
Space Systems Division
Distributed Scaleable Architecture is Based on Industry Standards Maximizing Transparency and Maintainability

- Data Base Driven
- Commercial Off-the-Shelf Hardware and Software
- Integrated Vehicle and Launch Architecture Synergism
- Distributed, Remote Processing
- Compatible with Emerging Government and Industry Systems
- Distributed, Networked and Real-Time Systems
- Expert Systems Applications to Real-Time and Ground Systems
Autonomous Control Structure Provides for Distributed and Segmented Systems

System is Completely Core Compatible
Control of Interfaces Maximizes Compatibility and Re-Use Reducing Long-Term Program Cost

Test Bed

UUT

Interface Test Adapter

Hardware Interface

Simulators

CPU

Non-Specific

Operations Environment (System Language)

Data

Content & Architecture

System Allows for Use of Multiple Vendor Hardware Platforms

User

Controlled Interfaces

RI-SSD

P. D. Schoen

Rockwell International
Space Systems Division

6/14/91
Intelligent Data Management Architecture Reduces Analysis Time and Cost (Automation)
RI-ASSTC is Putting the System Architecture to Action

RI-SSD
6/14/91

P. D. Schoen
Shuttle Mission Support Room (MSR)
Data Display and Review (DDR) Room
MSR and DDR Applying Systems Concepts To Shuttle Support

- **Member of Emergency Mission Control Center (EMCC)**
  - MILA Data Link Independent from JSC

- **Real-Time Monitoring of the Vehicle During Mission & Pre/Post-Launch**
  - Provides Subsystem Engineers Visibility on Vehicle Performance
  - Processing of Two Vehicles Simultaneously
  - Real-time Data Processing and Displays
  - Post Processing

- **Currently Upgrading Workstation Architecture**
  - Architecture has Front End Processor, Server, and User Workstations
  - Rehost of MEWS Software from MER on Sun 4 for Use in Downey
  - Dataview Display Builder for User Configurable Displays
Shuttle Checkout and Mission Support Datalink Provides Real-Time Integrated Satellite/Ground Systems
MSR/DDR Upgrade System Architecture Enables Greater Mission Support Capabilities
Expert Systems Enhance the DD&R Room Flight Support

- Improves Effectiveness of Subsystem Engineers
- Faster, More Accurate Malfunction Diagnosis
- Increased Safety
- Expert Knowledge Captured and On-Line
- Reduced Training Costs
  - Both Expert and Trainee
  - Rockwell OMS Ground Estimates 50% Savings
- Generic Architecture Can Support Multiple Programs
- Has been Used and Demonstrated to be Effective
ASSTC is Applying ES Technology to Mission Support

- LIFTOFF/ASCENT
  - Abort Region Determinator
  - SSME

- ON ORBIT
  - Flight Anomaly Manager ES
  - OMS Burn Monitor
  - MPS
  - EPD&C

- PRELAUNCH
  - OMS Prelaunch Monitor
  - SSME Expert System

- Flight Anomaly Manager (FAM)

- DEORBIT/LANDING
  - OMS Burn Monitor
FAM Interprets Output of Subsystem Expert System

- DATA LINK
- DECOM
- DATA SERVER

SUB-SERVERS
- MSB SUB-SERVER
- DD&R SUB-SERVER
- OFFICE AREA SUB-SERVER
- OTHER LOCATIONS

LEVEL 1
- SUBSYSTEM SPECIFIC EXPERT SYSTEMS
  - BBME
  - OMS
  - EPDC
  - IMU
  - FUEL CELLS
  - ECLSS
  - APU

LEVEL 2
- CRITICAL FUNCTION AUDIT
  - ELEMENT INTERACTION
  - SUBSYSTEM INTERACTION
  - FAILURE SCENARIO
  - RECOVERY PROCEDURE

- FLIGHT ANOMALY MANAGER EXPERT SYSTEM (FAM)

- DATA BASE
  - FLIGHT RULES
  - MISSION RQTS
  - SPECS
  - HANDBOOK
  - NASA & RI TECH EXPERTS

RECOMMENDATIONS TO MANAGEMENT

Rockwell International
Space Systems Division

RI-SSD
6/14/91

P. D. Schoen
16
Flight Anomaly Manager

- Provides Mission Support Team Leader with Overall Vehicle Status
  - Knowledgeable About Subsystem to Subsystem Interactions
    - Knows the Effect of Failure on Other Subsystems
    - Provides Management Insight into Vehicle Status
    - Makes Recommendations
    - Communicates with Subsystem Specific Expert Systems

- Multi-Layered Implementation
  - Sun Workstation Using G2
  - Communication with Subsystem Specific Expert Systems via GSI

- Interacts with Subsystem Specific Expert Systems
  - EPD&C
  - OMS
  - SSME
  - Fuel Cells
  - ECLSS
Ground Support - Summary

- RI-SSD has Developed and Delivered a Number of "Turn Key" Systems
  - ATE
  - Simulation Support
  - Factory/Flight Line
  - Payload Integration
  - Mission Support

- The Methodology being Used Allows for the Growth and Support of the System throughout the Life Cycle of a Program
  - Scaleable
  - Adaptable

- The Ground System Architecture Provides for Data and Procedure Transportability throughout the Life Cycle

System Architecture Provides for Generic Application to Any Program

RI-SSD

Rockwell International
Space Systems Division

P. D. Schoen

6/14/91
Aerospace Simulation & Systems Test Center

A. J. Mauceri, Director
(213) 922-4935
Comnet 372-4935
<table>
<thead>
<tr>
<th>Environment</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avionics &amp; Payload Test</td>
<td>Subsystem/LRU Breadboarding, Payload Integration and Compatibility Testing</td>
</tr>
<tr>
<td>Real-Time Mission Support</td>
<td>Flight Line Support and Ground Checkout Support Air-To-Ground Communications / Protocol Secure Systems</td>
</tr>
<tr>
<td>Man / Machine Interface</td>
<td>Interactive Display and Control Development Human Engineering Studies Crew Procedures, Familiarization and Training Natural Language Interfaces</td>
</tr>
<tr>
<td>Automation &amp; Robotics</td>
<td>Robotics Research, Vision System Development Space-Based Construction and Servicing Man-In-The-Loop Operations</td>
</tr>
<tr>
<td>Hardware/Test-System Development</td>
<td>Microprocessor Systems Data Link and Telemetry Communications Hardware Simulators Avionic System Interfaces Deliverable Test Systems and Remote Checkout Systems</td>
</tr>
</tbody>
</table>